controls the valves 124 and 126.

With the arrangement as shown in Figure 8 accurate temperature control of the stage cooling plug 106 and the second stage cooling plug 108 is achieved. With both of these systems the temperature can be maintained within an acceptable range for the particular product being extruded. With the above arrangement, accurate control of the first stage is achieved to effect a desired amount of cooling of the product without damage to the product. Excessive cooling can cause the product to be brittle whereas a controlled cooling of the part allows the product to be cooled and is referred to as tempered plastic. With the arrangement as shown in Figure 8 the extruder is capable of forming product much faster without wastage of the initial product. This is possible due to the controlled cooling and precision possible with the temperature feedback arrangement and the control of the two control valves 124 and 126.

An alternate system is shown in Figure 9. Once again the cooling plug has a first stage cooling plug 131 and a second stage cooling plug 133. A temperature sensor 140 is associated with the first stage cooling plug 131. The system 130 of Figure 9 provides precision control over the first stage cooling and general cooling of the second stage cooling plug 133 as will be fully described.

The system 130 includes a reservoir 132 which is part of a chiller. The reservoir 132 is used to maintain the cooling media at a desired temperature. Pump 134 causes the cooling medium to flow through line 136 to the first stage cooling plug 131 whereby the first stage cooling plug is essentially at and maintained at the temperature of the reservoir. The cooling medium is

returned to reservoir 132 through the return line 138. The reservoir 132 includes its own sensor 142 which is used by the controller 144 to vary the amount of cooling water provided through supply line 148 to the heat exchanging coil 150. The amount of flow through the coil 150 is adjusted by the control valve 160. Thus the control valve 160 is adjusted by the temperature sensor 142 and/or the temperature sensor 140 whereby the temperature of the reservoir is maintained at a desired set temperature. Thus the operator can set the temperature of the reservoir which effectively determines the temperature of the first stage cooling plug 131. With this arrangement the cooling plug is maintained at the desired temperature and the amount of fluid pumped through the cooling plug assures the cooling provided to the extruded product does not substantially change the temperature of the cooling plug. Any variation due to the shape of the product being produced does not produce a damaging variation of the temperature of the cooling plug. With this arrangement the operator can set and maintain the desired temperature of the cooling plug 131 within a relatively narrow range. With this arrangement tempering of the product as it is being used is achieved as the product passes over the first stage and once the product has been effectively tempered it is then possible to continue to remove heat from a product by the second stage cooling plug 133. Control of the actual temperature of second stage is not as critical and in this case cooling for the second stage is provided by tapping into the supply line 148 to provide a cooling source for the supply line 154 of the second stage cooling plug 133. The return line for the second stage cooling plug is shown as 156 and taps into the discharge line 152.

With the arrangement as shown in Figure 9 the

precision control on the first stage cooling plug allows general cooling in the second stage while still allowing excellent control of the product. This arrangement is also suitable for allowing fast setup of the extruder without damage of the initial product being extruded. Furthermore, the control arrangement provides for good response to other environmental conditions such as variations in the extruder, variations in the production rates; ambient temperatures etc. This is also true of the system of Figure 8 however in Figure 8 additional control is achieved due to the tracking of the second stage cooling plug 108.

The system described in the present application shows the overall control system for an extruder. This ability to provide different monitored cooling of a first stage and second stage cooling plug is also advantageous in retro-fit applications. As can be appreciated a single stage cooling plug of a length corresponding to the two stage cooling plug of Figure 10 can be replaced by the two stage cooling plug 170. Such a two stage cooling plug can be used with either of the control systems of Figures 8 and 9.

In some extruders perhaps only a single stage cooling plug is necessary and the cooling plug 172 can be inserted. In this case, either the temperature control as described in Figure 8 can be used for the first stage or the temperature control of Figure 9. Variations in length of the cooling plug can be adjusted by using a fill-in plug at the downstream portion of the cooling plug 172 if necessary.

The cooling plugs as shown in Figures 8 and 9 are preferably dependent of one another to reduce the amount of heat transferred between the plugs. If desired the

plugs can include additional structure at the junction to further reduce the heat transfer therebetween. Basically, the breaking of the plug into a first stage and a second stage does allow if desired the ability to provide a partial thermal break therebetween.

The earlier figures describe variations of the control valves associated with a first stage and a second stage. In accordance with the shape of the product being produced. Knowledge of the shape of the product can be used for adjusting of the control valves to achieve a desired degree of cooling. In Figures 8 and 9 sensing of the temperature associated with the cooling plugs and/or the temperature of the fluid in the discharge lines can be used as a feedback mechanism for varying the position of the control valves. In this system it is not necessary to know the product being extruded as the control valve is very quickly to achieve the desired degree of cooling. In the system of Figure 9 a reservoir is controlled to provide cooling fluid at a desired temperature and the amount of fluid provided to the first stage plug is such that to a large extent it is not appreciably effected by changes in the shape of the product being extruded. Such a system is more forgiving with respect to initial product being produced as well as any changes which occur during the production process.

With the systems as described over cooling of the cooling plugs is avoided and as such the temperature of the cooling plugs do not appreciably vary which could cause excessive cooling of the product and damage to the product. This possibility of damaging of the product is more pronounced in association with the first stage cooling and typically the second stage cooling is less vulnerable to wide temperature variations which cause product damage. Depending upon the particular

application and the type of product being produced control of the second stage as set out in the application is also desired.

Although various preferred embodiments of the present invention have been described in detail, it will be appreciated by those skilled in the art that variations may be made without departing from the spirit of the invention or the scope of the appended claims.